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**(12) United States Patent**  
**Garg****(10) Patent No.: US 6,601,080 B1**  
**(45) Date of Patent: Jul. 29, 2003****(54) HYBRID REPRESENTATION SCHEME FOR FACTOR L IN SPARSE DIRECT MATRIX FACTORIZATION****(75) Inventor: Rajat P. Garg, Sunnyvale, CA (US)****(73) Assignee: Sun Microsystems, Inc., Santa Clara, CA (US)****(\*) Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.**(21) Appl. No.: 09/510,911****(22) Filed: Feb. 23, 2000****(51) Int. Cl.<sup>7</sup> ..... G06F 7/38****(52) U.S. Cl. .... 708/502; 708/490****(58) Field of Search .... 708/446, 607, 708/160, 200, 490, 520; 710/68; 707/101****(56) References Cited****U.S. PATENT DOCUMENTS**

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A system that efficiently performs a CMOD operation in solving a system of equations involving a sparse coefficient matrix by identifying supernodes in the sparse matrix. Each supernode comprises a set of contiguous columns having a substantially similar pattern of non-zero elements. The system performs a CMOD operation on each supernode, by determining a structure for the supernode, and computing a function of the structure. The system uses a one-dimensional trapezoidal representation for the supernode during the CMOD operation, if the result of the function is lower than a threshold value, and otherwise uses a two-dimensional rectangular representation for the supernode. The function of the structure of the supernode is a function of a number of computational operations involved in computing a lower-triangular sub-block portion of the supernode and a number of computational operations involved in computing a rectangular sub-block portion of the supernode.

**18 Claims, 7 Drawing Sheets**